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Caries risk assessment and caries risk management by risk assessment after graduation: university dental school alumni use, attitudes, and beliefs

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ABSTRACT

Aims: This project examined the acceptance and use of Caries Management by Risk Assessment (CAMBRA) by the university dental school alumni after graduation.

Methods: In 2011, a university dental school implemented a CAMBRA Competency Examination (CE) for assessing students' ability to conduct a caries risk assessment and preventive plan. A survey was distributed in 2020 to 5,000 university dental school alumni who graduated between 1975 and 2019 which assessed their use and beliefs regarding Caries Risk Assessment (CRA). Alumni were placed into two groups for purposes of analysis: Group 1(G1): those who graduated prior to 2013 (n=373) and Group 2 (G2): those who graduated in or after 2013 (n=213).

Results: There was an overall response rate of 12% as 586 alumni responded to the survey. Overall, most (82.59%) of the survey respondents routinely assessed for caries risk, with 31.82% using a standardized tool. 42.83% of the respondents strongly agreed that CRA could predict the risk of future caries. There were significant differences between groups in terms of routine use of CRA (39.68% in G1 vs 48.36% in G2); very strong belief that a dentist's use of CRA can predict the future risk of caries (39.68% vs 48.36%); extreme importance of active caries when determining a preventive plan (38.16% vs 53.43%); and always treating children with incipient lesions with in-office fluoride (61.56% vs 76.02%) (all p<.05).

Conclusion: The alumni who graduated after the implementation of the competency examination used CAMBRA to a greater extent than those who graduated before its implementation, suggesting a possible paradigm shift.

Keywords: CAMBRA, alumni, competency, caries risk assessment

INTRODUCTION

It is estimated that oral disease affects approximately 3.5 billion people worldwide, with caries of permanent teeth being the most common condition. Globally, approximately 2 billion people suffer from caries of their permanent teeth and 520 million children suffer from caries of their primary teeth.[1] The medical model of caries management is among the principles of minimally invasive dentistry that encourages the prevention of disease or the interception of the disease process in its early stages in order to preserve tooth structure. CAMBRA (Caries Management by Risk Assessment) is a philosophy that has been developed over the past decades to help the practitioner assess the patient's risk for developing caries. This assessment is used to best manage the patient's treatment. The protocol involves determining the caries risk level by evaluating the many risk factors and protective factors of the patient. Treatment, depending on the caries risk, is multifaceted and could include the use of prescription fluoride, nutritional counseling, oral hygiene instructions, placement of silver diamide fluoride, placement of dental sealants, dry mouth intervention, and increased frequency of diagnostic radiographs/check-up.

Several caries risk assessment tools have been described in the literature such as the American Dental Association tool, American Academy of Pediatric Dentistry tool. The California Department of Health Care Services tool, Cariogram, among others. Several of these caries risk assessment tools have not been validated by clinical studies. Both CAMBRA and the Cariogram have been examined in multiple clinical studies and have been found to have good risk assessment capabilities.[5] Studies have demonstrated that the clinical significance of implementing the CAMBRA protocol in the reduction of dental caries worldwide.[3-5] In support of this in practice, a randomized controlled trial trained 30 dentists in private practice to utilize the CAMBRA protocol, and demonstrated that caries risk level, and caries disease indicators, were significantly reduced in the patients who were randomized to utilize the study protocol as compared to those who did not.[3] In 2009, most dental school students responded to having caries risk assessment training in their predoctoral program.[6] This university dental school is no exception, largely due to the introduction of the CAMBRA competency examination

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(CE) that has been in effect since 2011 with the graduating class of 2013 being the first class to complete a CAMBRA CE. The CAMBRA competency was a patient-based exam. This was essentially a performance assessment, and two calibrated faculty would use a rubric to evaluate their skill/knowledge. Students were encouraged to screen their patient at either the routine exam appointments and choose higher risk individuals. The student would then schedule the competency exam and they would be evaluated. Although the concept for CAMBRA is taught and is considered the ideal care, there is no evidence that this philosophy is practiced post-graduation. The aim of this project was to determine the use, attitudes and beliefs of dental school alumni regarding CAMBRA since the inception of the Clinical CAMBRA competency exam. The hypothesis was that the use, attitudes and beliefs of alumni who graduated after 2013 would be in greater alignment with CAMBRA philosophy in their practices than those who graduated before 2013.

Although the concept for CRA (Caries Risk Assessment) and management is taught to the undergraduate students and exists as a clinical guideline, there is no evidence that this philosophy is practiced post-graduation. Alumni have certainly gained the knowledge to surgically treat teeth and are expected to use this skillset to treat patients, but whether or not they were assessing the patient's caries risk and educating their patients about disease management prior to treatment planning was unclear. The CAMBRA clinical curriculum at this university dental school may help to determine the application of this philosophy in the everyday practice of the alumni.

METHODS

Ethics

The study was carried out with the permission of Tufts University Health Sciences Institutional Ethics Review Board (Date: 30.01.2020, Decision No: STUDY00000226). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The present study evaluated the success of the CAMBRA clinical curriculum at this university dental school through use of a questionnaire survey that was sent to alumni of this program who had graduated between 1975 and 2019.

Study Population

The study population consisted of those who graduated from a university dental school's Doctor of Dental Medicine (DMD) program between 1975 and 2019, who were actively practicing dentistry one or more days a week, and who practiced General Dentistry, Pediatric Dentistry, Prosthodontics, or Public Health Dentistry.

The year 2013 was the transition period when the training and implementation of the CAMBRA CE was fully supported. Since we wanted to examine differences in the beliefs, attitudes, and use of CAMBRA between those who had CAMBRA CE in clinic and those who did not, two comparison groups were created: Group 1 (G1) were those who graduated between 1975 and 2012 and Group 2 (G2) were those who graduated in or after 2013 to 2019.

The selected specialties were primary care dentists, who are often first points of contact to patients and provide comprehensive care management, including preventive services. The 1975 cut off year was decided upon since those who graduated at this early date would be close to retirement (or retired). The survey instrument described below was distributed to 5,000 university dental school alumni in 2020.

Survey

The research team created an electronic survey on Qualtrics to assess the use, attitudes and beliefs of CRA and CRM principles based on the CAMBRA philosophy. Content and face validity testing were conducted for quality assurance of the survey. The survey was updated based on responses received in this exercise. The 68-question survey was focused on topics regarding the use of CAMBRA, as well as the beliefs of this evidence-based science. The survey questions consisted of 44 Likert Scale, 7 demographic, 7 multiple-choice, 5 yes/no, and 5 qualifying questions. The estimated time to complete the survey was 15 minutes. Each survey link included an Information Sheet, which contained all required elements of consent to which the participants were required to agree. The survey is included as a supplement in the Appendix.

Survey Administration

The research team distributed the survey through two different venues. The first venue was during a 2020 dental congress at the university dental school alumni booth. Participants could access the survey with their electronic handheld device by scanning a QR Code provided by Qualtrics or with an iPad provided by the study team and scanning an anonymous link provided by Qualtrics. The second venue was via the university dental school alumni emails linked to Qualtrics.

Recruitment Methods

The IRB approved recruitment script was read to interested participants at the alumni booth. Displayed was a poster detailing the research study and promoting a raffle of gift cards as incentive for study participation and survey completion; paper copies of the information sheet were made available if subjects preferred to read a printed copy. Participants taking the survey at the dental congress were eligible to win one $500 American Express gift card.

In addition, a recruitment email with the survey link was distributed through the university dental school alumni network. The research team distributed the survey in January 2020. Six reminders were sent spanning 10 weeks after the initial distribution. Participants taking the survey in response to the email blast were eligible to win one of ten $100 American Express gift cards. Recruitment emails contained language that asked participants who had already responded to the survey to ignore the reminder.

Statistical Analysis

Frequencies and percentages were calculated for each item on the survey. Differences in selected demographic, CRA and CRM (Caries Risk Management)factors between the two comparison groups were assessed using the chi-square test for categorical variables and the Mann-Whitney U test for Likert scale questions. The statistical significance level was set at 0.05 for global tests. SAS Version 9.4 (SAS Institute Inc., Cary, NC) was used for analyses. Cronbach statistical test was performed to assess the internal consistency of the questionnaire.

RESULTS

Study Population Characteristics

The survey response rate was 12% and the total number of participants who completed the entire survey was 586. The survey was administered to 4,883 of the approximately 8000 graduates of the dental school up to 2019. The study population was divided into 2 comparison groups: G1 (n=373): those who graduated before 2013, and G2 (n=213): those who graduated in/or after 2013 up to 2019. In this study sample, 48.29% of the respondents were men and 51.71 % were women. Most (87.37%) of the participants were engaged in general dentistry, 7.00 % were pediatric dentists, 1.71% were prosthodontists and 3.92% were involved in Public Health. Of the study population, 63.99% had been in practice for nineteen years or less. Specifically, 24.06% had been in practice for less than 5 years, 19.11% for 5-10 years, 20.82% for 10-19 years, 17.58% for 20-29 years, 17.92% for 30-39 years and 0.51% for over 40 years.

The place of employment differed between the two graduation groups with more participants from G1 (82.59%) being involved in private practice than in G2 (67.61%). Additionally, more diverse places of employment were reported from participants in G2, such as corporate, Armed forces, and Mobile Dental Health Clinics. (Table 1).

Table 1. A table demonstrating the study population characteristics

Categories	Subcategories	Group 1 n (%)	Group 2 n (%)
Age	<35 years	8 (2.1)	178 (83.6)
	35-44 years	130 (34.9)	32 (15.0)
	45-54 years	97 (26.0)	3 (1.4)
	55-64 years	119 (31.9)	0 (0)
	65 years and over	18 (4.8)	0 (0)
Gender	Male	207 (55.5)	76 (35.7)
	Female	163 (43.7)	135 (63.4)
	Prefer not to answer	3 (0.8)	2 (0.9)
Race	White	263 (70.5)	133 (62.4)
	Black or African American	6 (1.6)	13 (6.1)
	American Indian or Alaskan Native	1 (0.3)	1 (0.5)
	Asian	69 (18.5)	59 (27.7)
	Native Hawaiian or Pacific Islander	4 (1.1)	0 (0)
	Other	12 (3.2)	4 (1.9)
	Prefer not to answer	25 (6.7)	10 (4.7)
Ethnicity	Latino	16 (4.3)	15 (7.0)
	Non-Hispanic	308 (82.6)	177 (83.1)
	Prefer not to answer	49 (13.1)	21 (9.9)
Place of employment (*)	Private practice	308 (82.6)	144 (67.6)
	Corporate health center	8 (2.1)	23 (10.8)
	Armed forces	6 (1.6)	8 (3.8)
	Other government services	6 (1.6)	2 (0.9)
	Mobile dental clinic	22 (5.9)	21 (9.9)
	Community health center	10 (2.7)	7 (3.3)
	Academic institution	4 (1.1)	4 (1.9)
	Hospital	9 (2.4)	4 (1.9)
	Other (text)	6 (1.6)	3 (1.4)

The Cronbach- alpha value was 0.75, indicating that the internal consistency of the questionnaire was acceptable.

CRA & CRM Use, Attitudes and Beliefs

Overall, most (82.59%) of the survey respondents routinely assessed for caries risk, with G1 representing 80.16% and G2 representing 86.85%. The chi-square test concluded that there was a statistically significant association between graduation groups and routinely assessing patient's risk of developing caries (p=.04). The p-value for the Mann Whitney U test demonstrated a statistically significant difference between graduation groups on how strongly they thought a CRA could predict the risk of caries in the future. There were 39.68% of G1 and 48.36% of G2 participants who reported that they strongly agreed that a dentist's assessment of caries risk could predict whether or not the patient develops caries(p=.02). (Table 2) For those who did not use a standardized tool (68.18%), there was a significant difference between graduation groups and how often they gave an individualized preventive treatment plan (p=.004) with 45.00% of G1 and 42.59% of G2 reporting that they frequently gave individualized preventive treatment plans.

Table 2. A table summarizing the CRA use and attitudes for graduation groups 1 and 2

Q: How strongly do you agree with this statement: a dentist's assessment of caries risk for a patient can predict whether or not that patient develops new caries in the future

Response	Very strongly agree	Strongly agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Group 1, %	39.68	33.51	3.45	17.24	16.09
Group 2, %	48.36	31.46	4.69	3.76	11.74

P=.02

Overall, the majority of survey respondents' belief was that 76% strongly agreed or agreed that CRA could predict the future of caries risk; 39.68% in G1 strongly agreed compared with 48.36% in G2. Approximately fifty six percent (55.97%) overall believed that having a specific protocol /form increased the reliability of a CRA.

When the attitudes of the participants were assessed, these were the findings: when asked about their ability to complete a CRA, 90.27% answered "very good or good". When asked about their ability to complete a preventive treatment plan, 85.32% answered "very good or good". Approximately eighty-six (85.51%) percent of the respondents gave individualized preventive plans to "almost every patient" or "with most patients". Of the 31.82% of the population who used a standardized CRA tool, ninety percent (90.26%) used it "with almost every patient" or with "most patients".

Treatment of Children

The Mann Whitney U test displayed significant differences between graduation groups on how often they administered an in-office fluoride application such as fluoride gel or varnish (p=.0004), how often they recommended an OTC fluoride rinse (p=.001) and how often they recommended xylitol chewing

gum or mints (p=.004) to children (ages 6-17) with at least one white spot lesion. 61.56% of G1 participants and 76.02% of G2 participants always administered in-office fluoride application. 33.53% of G1 participants and 27.04% of G2 participants always recommended OTC fluoride rinse while 33.53% of G1 participants and 39.80% of G2 participants rarely recommended xylitol chewing gum (Table 3). Additionally, results showed significant differences between groups on the importance of decreased salivary flow (p=.05) and socio-economic status (p=.01) when deciding on a preventive treatment plan for children. 57.80 % of G1 participants and 50.00% of G2 participants reported that decreased salivary function was extremely important when deciding on a preventive treatment plan. 23.99% of G1 participants and 32.14% of G2 participants reported that the patient's socioeconomic status was very important when deciding on a preventive treatment plan. (Table 4) Additionally, 37.24% from G2 and 35.26% of G1 believed that the history of caries (within the last 3 years) was very important when deciding on a preventive treatment plan, and 45.92% of G2 and 39.60% of G1 participants believed that the presence of dental appliances was very important when developing a preventive treatment plan. When asked about the application of dental sealants, 58.67% of G2 and 55.49% of G1, always applied sealants on permanent teeth with pits & fissures.

Treatment of Adults

For patients over 18 years, Mann Whitney U test demonstrated a statistically significant difference between graduation groups when participants were asked about the importance of active carious lesion (p=<.0001), the importance of several large restorations(p=.04) as well as the importance of root exposure and recession(p=.0043) when deciding on a patient's preventive treatment plan. Of G1 participants 38.16% and 53.43 % of G2 participants reported that the presence of active caries was extremely important in deciding on preventive treatment plans. 42.16% of G2 participants and 37.05% of G1 participants reported that the presence of large restorations was very important in deciding on treatment. 37.60% of G1 participants and 27.45 % of G2 participants reported that recession and root exposure were extremely important in deciding on preventive treatment plans (Table 5).

Table 3. A table comparing the differences in graduation groups on how often they administer in-office fluoride application, recommend OTC fluoride rinse or xylitol chewing gum in children with white spot lesions.

Q: How often do you prescribe in office fluoride, OTC fluoride rinse or xylitol chewing gum in children with white spot lesions?

	Response	Always	Frequently	Sometimes	Rarely	Never	P values
Group 1, %	In-office fluoride	61.56	30.35	5.78	2.02	0.29	.0004
	OTC Fluoride rinse	33.53	38.44	19.65	6.65	1.73	.001
	Xylitol chewing gum	5.78	13.01	28.32	33.53	19.38	.004
Group 2, %	In-office fluoride	76.02	20.92	2.55	0.51	0.00	
	OTC Fluoride rinse	27.04	28.57	26.02	13.78	4.59	
	Xylitol chewing gum	4.08	8.67	21.43	39.80	26.02	

Table 4. A table comparing the differences between graduation groups on the importance of decreased salivary flow and socio-economic status when deciding on treatment plans for children

Q: How important are decreased salivary flow and socio economic status when deciding on treatment plans for children?

	Response	Not at all	Slightly important	Important	Very important	Extremely important	P values
Group 1 %	Decreased salivary flow	1.16	3.76	7.23	30.06	57.80	.05
	Socioeconomic status	16.47	15.90	28.90	23.99	14.74	.01
Group 2 %	Decreased salivary flow	1.02	3.57	13.78	31.63	50.00	
	Socioeconomic status	6.12	12.76	35.71	32.14	13.27	

Table 5. A table comparing the differences between graduation groups on the importance of the presence of active carious lesions, several large restorations or root exposure when deciding on the treatment plans of adult patients

Q: How important are the presence of active carious lesions, several large restorations or root exposure when deciding on the treatment plans of adult patients?

	Response	Not at all	Slightly important	Important	Very important	Extremely important	P values
Group 1 %	Active carious lesions	0.56	5.85	15.60	39.83	38.16	<.0001
	Large restorations	0.84	7.52	27.58	37.05	27.02	.04
	Root exposure	0.56	5.01	14.48	42.34	37.60	.0043
Group 2 %	Active carious lesions	0.49	0.00	11.27	34.80	53.43	
	Large restorations	0.,00	6.86	19.12	42.16	31.86	
	Root exposure	0.98	5.39	23.04	43.14	27.45	

DISCUSSION

The CAMBRA protocol consists of evidence-based clinical recommendations for the most effective interventions in the arrest or reversal of non-cavitated and cavitated dental caries, using non-restorative treatments in children and adults. These recommendations have been formulated by an expert panel that made 11 clinical recommendations, each specific to lesion type, tooth surface, and dentition. These recommendations include the use of 38% silver diamine fluoride, sealants, 5% sodium fluoride varnish, 1.23% acidulated phosphate fluoride gel, and 5,000 parts per million fluoride (1.1% sodium fluoride) toothpaste or gel, among others.[8]

In this study 39.68% and 33.51% of G1 and 48.36% and 31.46% of G2 participants either strongly or frequently agreed that the dentist's assessment of caries risk was a predictor for the patient's future caries risk. This was similar to the results from a study on dental hygienists in 2015 where 34% and 55% of the participants strongly agreed and agreed with this statement.[9]

Though the overall results demonstrated some alignment with the CAMBRA philosophy when treating adults; and a much greater alignment with the philosophy, when treating children[6], several results favored G2 participants and therefore suggest that the introduction of the CAMBRA CE for the G2 participants may have had a significant role in influencing their implementation of CAMBRA philosophy in their daily practice. Based on these results of this study the hypothesis was accepted. G2 participants were generally in alignment with the CAMBRA principles in their practices.

The G2 participants, however, differed from the expected trajectory with the belief that salivary function was extremely important when deciding on a preventive treatment plan. This may be attributed to the recent shift in caries research with a greater emphasis on biofilm and biofilm modulation.

Questions regarding the importance of recognizing disease indicators (the history of caries, the presence of current caries, extractions due to caries and the presence of white spot lesions) in determining a caries risk level were also asked. In all but one category, G2 found the presence of the following disease indicators to be of greater importance when determining caries risk level: the presence of existing decay and the history of caries within the last 3 years was very important. Other factors that a majority of the participants deemed extremely important or very important in determining a preventive treatment plan were socio economic background (very important); presence of dental appliances (very important); age (extremely important); understanding the caries process (very important); and patient/guardian's commitment to follow up (very important). In the latter case, G1 found the presence of these factors of greater importance when determining a caries risk level than those in G2. These results demonstrated slightly greater, but statistically insignificant, knowledge in G1 with regards to the available evidence on the risk indicators and risk predictors of dental caries.[10-12]

When looking at the impact of socioeconomic factors on the caries experience, a systematic review found that among the children with dental caries, 35.9% were of low socioeconomic status (SES), 35.34% were of middle SES and 24.51% were of high SES. Children of low SES had 52.00% higher chance of acquiring dental caries while the high SES children had a 3% higher chance of acquiring dental caries.[13] A more recent study evaluated data that was extracted from the Bigmouth Dental Data Repository and found that the odds of being in the high-risk group were higher for people 49-64 years of age, people with co-morbidities, people with a Social Deprivation Index score above the 75th percentile as well as people with Black and Hispanic ethnicities.[14]

The results exhibit a statistically significant increase in the beliefs and use of CAMBRA philosophies and implicate a shift from the "drill and fill" mindset to a more evidence-based non-restorative management of caries, in those who graduated after the implementation of the CAMBRA CE. However, although this research leads us to believe that alumni beliefs of CAMBRA are shifting, there is still the need for more emphasis on the implementation of this science. Perhaps, more proactive methods of encouraging the implementation of CAMBRA principles such as using dental quality measures within electronic health records or with the use of artificial intelligence via clinical decision support tools should be put in place. A systematic review demonstrated that by implementing quality measures that focused on preventive or oral health services, practitioners can be prompted to prescribe caries prevention plans to at risk patients. The use of clinical decision support tools has the potential to improve caries diagnosis and management, based off of results extrapolated from a study on pediatric dental trauma. Medical students with limited knowledge on pediatric dental trauma reported significant improvement in the diagnosis and management of pediatric dental trauma after use of clinical decision support tools.[15-18]

Limitations

A limitation of this study is the assessment of a single caries assessment tool (CAMBRA). The study findings were also dependent on self-reported data, which may be subject to social desirability bias.

CONCLUSION

Within the limitations of the study, it was concluded that here was significantly higher implementation of the CAMBRA philosophy in the participants who graduated after the introduction of the CAMBRA CE in this school's curriculum with more practitioners including non-operative management of caries in their practice. There is however a need for more emphasis on this philosophy to increase implementation post-graduation.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Tufts University Health Sciences Institutional Ethics Review Board (Date: 30.01.2020, Decision No: STUDY00000226).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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